



# First record of *Chlorophyllum molybdites* (G. Mey.) Massee (Basidiomycota, Agaricaceae) from Piauí state, Brazil

Maria Helena Alves<sup>1</sup>, Mateus Oliveira da Cruz<sup>1</sup>, Cristiano Coelho do Nascimento<sup>2</sup>

**1** Universidade Federal do Piauí, *Campus* Ministro Reis Velloso. Avenida São Sebastião, 2819, Parnaíba, Piauí. CEP 64202-020, Brazil. **2** Instituto Federal do Piauí, *Campus* Piripiri. Av. Rio dos Matos, s/n – Germano, Piripiri, Piauí. CEP 74260-000, Brazil.

**Corresponding author:** Maria Helena Alves, [malves@ufpi.edu.br](mailto:malves@ufpi.edu.br)

## Abstract

*Chlorophyllum molybdites* (G. Mey.) Massee is a widespread poisonous mushroom, which when consumed causes severe gastrointestinal distress, including stomach irritation, vomiting and diarrhea. It is reported for the first time from Piauí state, Brazil. This species is described, illustrated and accompanied by color photographs of fresh basidiomes. Comments on the taxonomy are presented.

## Keywords

Biodiversity, taxonomy, new record, poisonous mushroom.

**Academic editor:** Roger Fagner Ribeiro Melo | Received 19 March 2019 | Accepted 1 August 2019 | Published 23 August 2019

**Citation:** Alves MH, Cruz MO, Nascimento CC (2019) First record of *Chlorophyllum molybdites* (G. Mey.) Massee (Basidiomycota, Agaricaceae) from Piauí state, Brazil. Check List 15 (4): 695–699. <https://doi.org/10.15560/15.4.695>

## Introduction

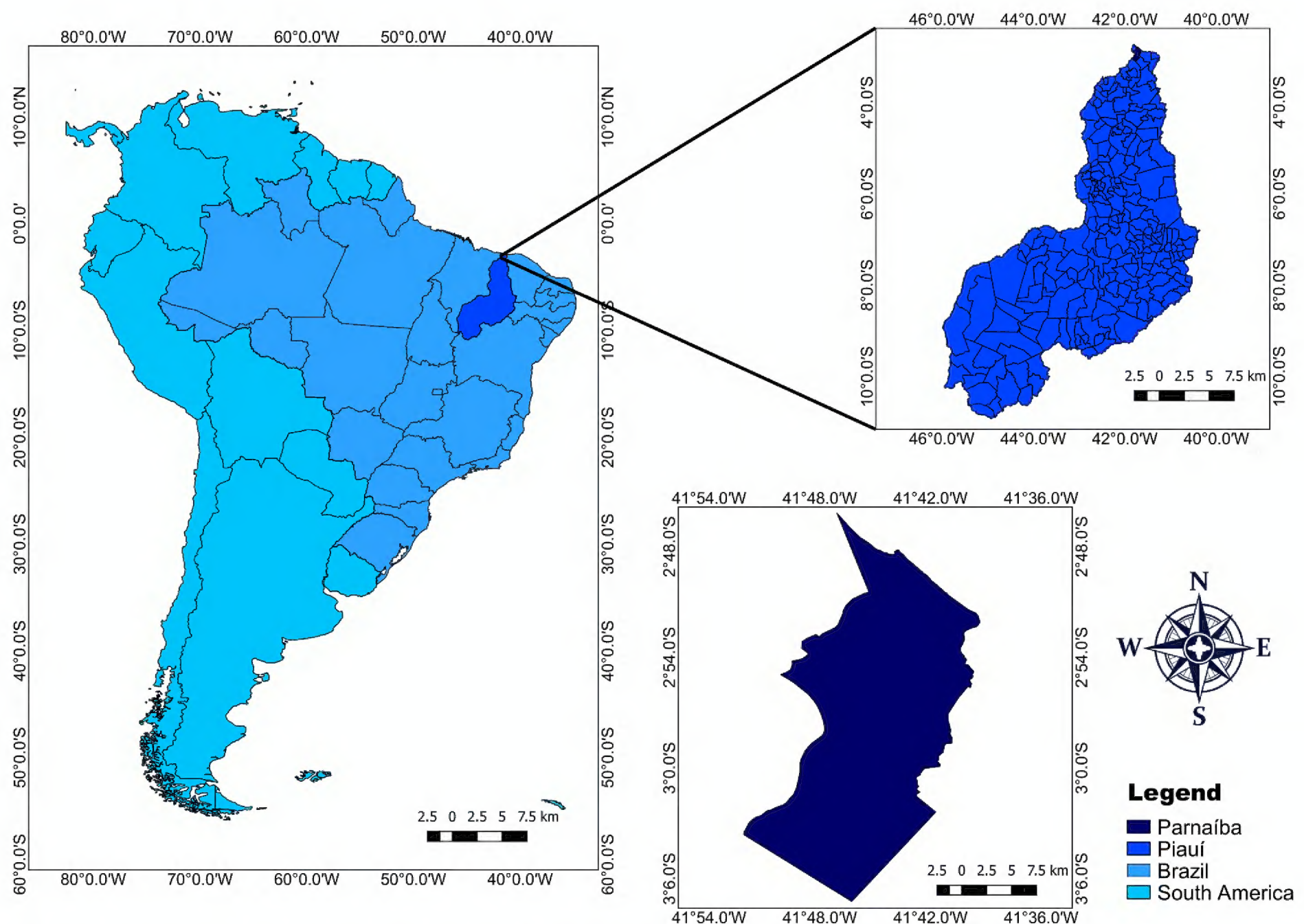
The genus *Chlorophyllum* Massee is monophyletic and has been classified in the euagaric family Agaricaceae Chevall, comprising approximately 16 species (Kirk et al. 2011). However, three additional species have recently been described by Crous et al. (2015) and three more by Ge et al. (2018). *Chlorophyllum* is widely distributed throughout the world, often growing in urban and ruderal habitats, with a preference for tropical and subtropical regions (Kirk et al. 2008, Vellinga 2004). Morphologically, members of this genus can be recognized by the following combination of characters: fleshy pileus with large, flat, brown or pale scales, made up of erect tightly packed cells (hymenidermal); stipe, if present, smooth; and basidiospores lack a germ pore or have a germ pore caused by a depression in the episporium without a hyaline covering. The basidiospores are white, green, brownish or brown in deposit, and the habit varies from

agaricoid, secotioid, or gasteroid (Vellinga 2001, 2002, 2003a, 2003b, Vellinga and Kok 2002, Vellinga et al. 2003, Ge and Yang 2006, Crous et al. 2015, Alves et al. 2016, Ge et al. 2018).

Based on morphological similarities added to the molecular evidence, some species were transferred from the genus *Macrolepiota* Sing. and *Lepiota* (Pers.) Gray to the genus *Chlorophyllum* (Ge et al. 2018). *Endoptychum agaricoides* Czern. has also been transferred to this genus based on molecular studies (Vellinga and Kob 2002, Gams 2005). Infragenetically, *Chlorophyllum* is divided into six sections (sect. *Chlorophyllum*, sect. *Ellipsoidospororum* Z.W. Ge, sect. *Rhacodium* Z.W. Ge, sect. *Parvispororum* Z.W. Ge, sect. *Endoptychum* (Czern.) Z.W. Ge and sect. *Sphaerospororum* Z.W. Ge) on the basis of both morphological and molecular evidence (Ge et al. 2018).

*Chlorophyllum molybdites* (G. Mey.) Massee, the type species of the genus, is a widespread poisonous





**Figure 1.** Location of collection, municipality of Parnaíba, Piauí state, Brazil.

mushroom. Its consumption causes severe gastrointestinal distress, including stomach irritation, vomiting and diarrhea (Berger and Guss 2005). In Brazil, this species is reported from six states: Rio de Janeiro (Pegler 1983), São Paulo (Espalor 2014), Rio Grande do Sul (Sobestiansky 2005, Alves et al. 2016), Paraná (Meijer et al. 2007), Paraíba (Furtado 2012) and Pernambuco (Reid and Eicker 1991).

This note reports the first record of *C. molybdites* from Piauí state, Brazil.

## Methods

Parnaíba, Piauí state (Fig.1), the collection point is located on the coastal plain with altitude of about 5 m. The semi-humid tropical climate predominates in the region, with high rate of rainfall from January to June, and annual temperatures ranges from 22 to 32°C (CEPRO 2013).

The collections took place in the rainy season, from December (2016) to January (2017), in a grassy area. Specimens were collected, documented and preserved using standard methods (Largent et al. 1986). The material was photographed in the field using a digital camera and extensive notes on the basidiomata were made before drying. Colours were named based on Kernerup and Wansher (1978).

Microscopic analysis of the material was performed using an Olympus BX41 microscope. All measurements

and colors reported for microscopic features were made from material rehydrated in 96% ethanol, followed by distilled water, 3% KOH or Melzer's reagent. At least 25 measurements were made of each microstructure. Spore statistics include: arithmetic means ( $\bar{x}_m$ ) of basidiospore lengths and widths  $\pm$  standard deviation measured for  $n$  objects; quotient of basidiospore length by spore width ( $E$ ) indicated as a range variation in  $n$  objects measured; the mean of  $E$ -values ( $Q$ )  $\pm$  standard deviations. The sample size ( $n$ ) = total number of basidiospores measured ( $x$ ) divided by the number of basidiomata studied ( $y$ ), as shown in the formula  $n = x/y$  (Largent and Abell-Davis 2011). The documented material has been deposited at the Herbarium Delta (HDelta), Department of Biology, Federal University of Piauí, Campus Ministro Reis Velloso.

## Results

***Chlorophyllum molybdites*** (G. Mey.) Masee. [= *Agaricus congolensis* Beeli. = *Agaricus molybdites* G. Mey. = *Chlorophyllum esculentum* Masee. = *Chlorophyllum molybdites* var. *congolense* (Beeli) Heinem. = *Chlorophyllum molybdites* var. *luteolosperma* Sing. Pap. Mich. = *Chlorophyllum molybdites* var. *marginatus* (A.H. Smith) D.A. Reid & Eicher. = *Chlorophyllum molybdites* (G. Mey.) Masee. var. *molybdites*. = *Lepiota molybdites* (G. Mey.) Sacc. = *Lepiota molybdites* var. *marginata*





**Figure 2.** *Chlorophyllum molybdites*. **A.** Habit. Scale bar = 2.7 cm. **B.** Bottom face showing lamellulae and stipe with ring. Scale bar = 1.5 cm. **C.** Superficial view of the pileus. Scale bar = 1.7 cm. Photos: Maria Helena Alves.

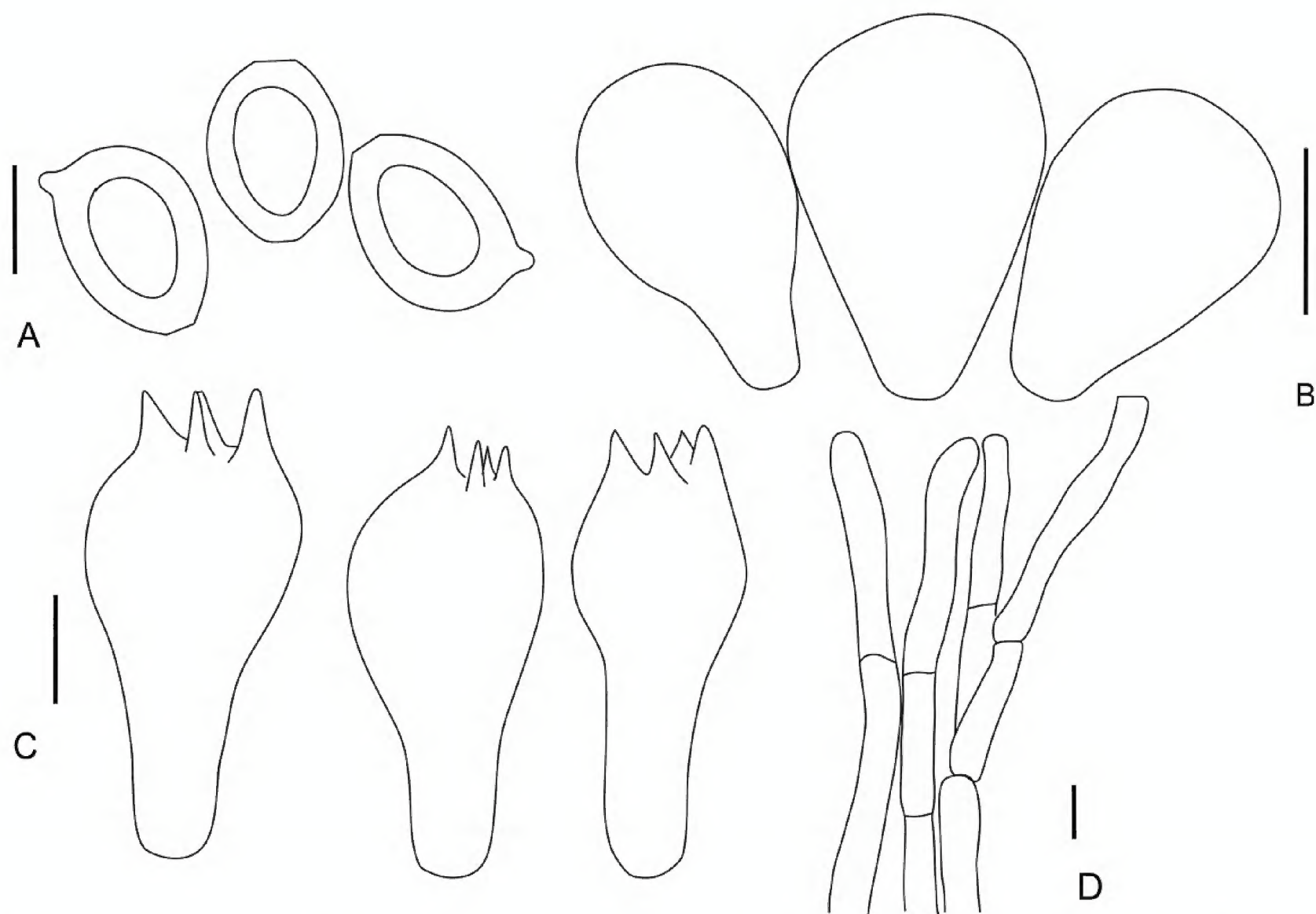
A.H. Sm. = *Lepiota molybdites* (G. Mey.) Sacc. var. *molybdites* = *Leucocoprinus molybdites* (G. Mey.) Pat. = *Macrolepiota molybdites* (G. Mey.) G. Moreno, Banares & Heykoop = *Mastocephalus molybdites* (G. Mey.) Kuntz.]. Figures 2 and 3.

**New records.** Brazil. Piauí: Parnaíba, Federal University of Piauí, (02°54'17"S, 041°46'36"W), Campus Ministro Reis Velloso, 21 Dec. 2017, leg. M.O. Cruz (HDELTA 5212).

**Known distribution.** Africa (Yongabi et al. 2004), China (Ge and Yang 2006), India (Bijeesh et al. 2017), Philippines (Zoberi 1972), Pakistan (Razaq and Shahzad 2012), Israel (Avizohar-Hershenzon 1967), Japan (Kobayashi et al. 2004), Yemen (Al-Fatimi et al. 2013), Australia (Vellinga 2003a), Hawaii (Blayney et al. 1980), Tahiti (Zoberi 1972), Canada (Reid and Eicker 1991), United States (Lehmann and Khazan 1992, Espinoza and Smith 2016), Puerto Rico (Marian et al. 2011), Colombia (Molano et al. 2010), Mexico (Pérez-Silva and Herrera 1986), Panama (Piepenbring 2008), Caribbean Region (Zoberi 1972), Venezuela (Dennis 1970), Argentina (Romano et al. 2013) and Brazil: Rio de Janeiro (Pegler 1983), São Paulo (Espalao 2014), Rio Grande do Sul (Sobestiansky 2005, Alves et al. 2016), Paraná (Meijer et al. 2007), Paraíba (Furtado 2012) and Pernambuco (Reid and Eicker 1991).

**Identification.** Basidiomes medium-sized to large. Pileus 5–11 cm in diam., ovoid at first, subhemispheric to hemispheric when expanding, plano-convex at maturity, with a low, broad and obtuse umbo; surface dry, longitudinally striate, white (29A1) at first, becoming cream (4A3), covered with brownish squamules that are uplifted or flat, and concentrated near the center; surface underneath scales finely fibrillose. Lamellae free, subcrowded to crowded, white (1A1) becoming greenish to green when mature (26D3), brownish (6E3) when dried; lamellulae attenuate, unevenly distributed, in 4 ranks. Stipe 5–12 × 0.8–1.3 cm, white (29A1) to beige (6C2) easily detachable from pileus, cylindrical to subcylindrical, widening downwards, base slightly enlarged, finely fibrillose. Annulus well developed, membranous, upper surface whitish, lower surface beige (6C3) to brownish (6E4), double-crowned. Odor and taste not distinctive. Spore print dull grayish green (30D4). Basidiospores  $9.4\text{--}11.7 \times 6.3\text{--}8.3 \mu\text{m}$  ( $X_m = 10.2 \pm 0.57 \times 7.0 \pm 0.52$ );  $E = 1.21\text{--}1.73$ ;  $Q = 1.4 \pm 0.11$ ;  $n = 30/2$ ), ellipsoid to elongate, thick-walled, smooth, light olive-green, dextrinoid, broad-truncate with wide germ pore. Basidia  $20\text{--}24 \times 9\text{--}10 \mu\text{m}$ , clavate, hyaline, 4-spored. Pleurocystidia absent. Cheilocystidia  $18\text{--}38 \times 14\text{--}20 \mu\text{m}$ , broadly clavate to sphaeropedunculate, hyaline, thin-walled. Lamella trama irregular, made up of subcylindrical hyaline hyphae, 8–13  $\mu\text{m}$  in diam.





**Figure 3.** *Chlorophyllum molybdites*. **A.** Basidiospores. **B.** Cheilocystidia. **C.** Basidia. **D.** Pileipellis. Scale bars: A–C = 6 µm (A–C); D = 9 µm. Drawings: Mateus Oliveira da Cruz.

Pileipellis a palisade of hyphae with terminal elements clavate to subfusiform, 7–20 µm in diam. Clamp connections not observed. Habit and habitat: saprotrophic, scattered to gregarious, terrestrial.

## Discussion

*Chlorophyllum molybdites* is assignable to sect. *Chlorophyllum*, which is characterized by olive to greenish-white basidiospores with a truncate apex, broadly clavate to sphaeropedunculate cheilocystidia and a palisade-like pileipellis of hyphae with terminal elements clavate to subfusiform (Ge et al. 2018).

The collection studied is very similar to those described by Pegler (1983), Meijer et al. (2007), Alves et al. (2016) and Bijesh et al. (2017). Both Alves et al. (2016) and Pegler (1983) present basidiospores with a lower Q value ( $Q = 1.3$ ). Whilst Bijesh et al. (2017) report a slightly higher Q value ( $Q = 1.5$ ). However, the Q value presented here follows the results of Meijer et al. (2007), which refers  $Q = 1.3$ – $1.6$ . The cheilocystidia are quite similar in size and shape to those described by Alves et al. (2016) and Bijesh et al. (2017).

In Brazil, in addition to *C. molybdites*, only two other species occur: *Chlorophyllum rachodes* (Vittad) Vellinga and *Chlorophyllum hortense* (Murrill) Vellinga (Alves et al. 2016). *Chlorophyllum molybdites* exhibit some morphological similarities to *C. rachodes*, with this being confused. However, *C. rachodes* can be distinguished by its white spore print and clavate stipe (Vellinga 2002, Vellinga 2006, Meijer et al. 2007).

## Acknowledgements

We thank the Federal University of Piauí for the support received during our research. MOC thanks Conselho Nacional de Desenvolvimento Científico (CNPq) for scholarship of Scientific Initiation.

## Authors' Contributions

MOC collected the material; MHA identified the species; MOC did the illustrations and organized the photos; MOC, MHA and CCN wrote the text.

## References

- Al-Fatimi M, Schroder G, Kreisel H, Lindequist U (2013) Biological activities of selected basidiomycetes from Yemen. *Pharmazie* 68: 221–226. <https://doi.org/10.1691/ph.2013.2729>
- Alves RP, Menezes GCA, Oliveira ED, Victoria FC, Pereira AB, Albuquerque MP (2016) *Chlorophyllum* Masee e *Macrolepiota* Singer (Agaricaceae) em área do bioma Pampa, Rio Grande do Sul, Brasil. *Neotropical Biology and Conservation* 11 (3): 141–152. <https://doi.org/10.4013/nbc.2016.113.04>
- Avizohar-Hershenzon Z (1967) *Chlorophyllum molybdites* (Meyer ex Fr.) mass in Israel. *Israel Journal of Botany* 16 (2): 63–69.
- Berger KJ, Guss DA (2005) Mycotoxins revisited: Part II. *The Journal of Emergency Medicine* 28 (2): 175–183. <https://doi.org/10.1016/j.jemermed.2004.08.19>
- Bijesh C, Vrinda KB, Pradeep CK (2017) Mushroom poisoning by *Chlorophyllum molybdites* in Kerala. *Journal of Mycopathological Research* 54 (4): 477–483.
- Blayney D, Rosenkranz E, Zettner A (1980) Mushroom poisoning from *Chlorophyllum molybdites*. *Western Journal of Medicine* 132 (1): 74–77.
- CEPRO (Fundação Centro de Pesquisas Econômicas e Sociais do Piauí)



- (2013) Diagnóstico Socioeconômico: Parnaíba. Governo do Piauí. <http://www.cepro.pi.gov.br/diagsococo.php>. Accessed on: 2019-3-18.
- Crous PW, Wingfield MJ, Guarro J, Hernandez-Restrepo M, Sutton DA, Acharya K, Barber PA, Boekhout T, Dimitrov RA, Duenas M, Dutta AK, Gene J, Gouliamova DE, Groenewald M, Lombard L, Morozova OV, Sarkar J, Smith MT, Stchigel AM, Wiederhold NP, Alexandrova AV, Antelmi I, Armengol J, Barnes I, Cano-Lira JF, Castaneda RRF, Contu M, Courtecuisse PR, Silveira AL, Decock CA, Goes A, Edathodu J, Ercole E, Firmino AC, Fouriem A, Fournier J, Furtado EL, Geering ADW, Gershenzon J, Giraldo A, Gramaje D, Hammerbacher A, He XL, Haryadi D, Khemmuk W, Kovalenko AE, Krawczynski R, Laich F, Lechat C, Lopes UP, Madrid H, Malysheva EF, Felix MY, Martin MP, Mostert L, Nigro F, Pereira OL, Picillo B, Pinho DB, Popov ES, Pelaez CAR, Latham RS, Denis SM, Shivas RG, Silva V, Disheval SMM, Telleria MT, Ullah C, Unsickern SB, Merwe NA, Vizzini A, Wagner HG, Wong PTW, Wood AR, Groenewald JZ (2015) Fungal Planet description sheets. Persoonia 34: 167–266. <https://doi.org/10.3767/003158515x688433>
- Dennis RWG (1970) Fungus flora of Venezuela and adjacent countries. Kew Bulletin Additional Series 3: 1–531.
- Espalor C (2014) Levantamento de fungos Agaricales coletados no Estado de São Paulo e depositados no Herbário SP. Trabalho de Conclusão de Curso, Instituto Federal de Educação, Ciência e Tecnologia, São Paulo, 212 pp.
- Espinoza L, Smith ME (2016) The green-spore poison parasol mushroom, *Chlorophyllum molybdites*. University of Florida Institute of Food and Agricultural Sciences, Gainesville, 4pp. <https://edis.ifas.ufl.edu/pp324> Accessed on: 2018-11-02.
- Molano FAE, Corrales A, Vasco-Palacios AM (2010) Macrohongos de colombia II. Listado de especies de los órdenes Agaricales, Boletales, Cantharellales y Russulales (Agaricomycetes, Basidiomycota). Actual Biología 32 (92): 89–114.
- Furtado ANM (2012) Fungos Agaricales (Basidiomycota, Fungi) da Mata Atlântica Metropolitana de João Pessoa, PB. Trabalho de Conclusão de Curso. Universidade Federal da Paraíba, João Pessoa, 118pp.
- Gams W. (2005) Report of the Committee for Fungi: 12. Taxon 54: 520–522. <https://doi.org/10.2307/25065386>
- Ge ZW, Yang ZL (2006) The genus *Chlorophyllum* (Basidiomycetes) in China. Mycotaxon 96: 181–191.
- Ge ZW, Jacobs A, Vellinga EC, Sysouphanthong P, Walt R, Lavorato C, Yang ZL (2018) A multi-gene phylogeny of *Chlorophyllum* (Agaricaceae, Basidiomycota): new species, new combination and infrageneric classification. MycoKeys 32: 65–90. <https://doi.org/10.3897/mycokeys.32.23831>
- Kirk PM, Cannon PF, Minter DW, Stalpers JA (2008) Ainsworth & Bisby's Dictionary of the Fungi. CABI, Wallingford, 771 pp.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA (2011) Dictionary of Fungi CABI, Wallingford, 640 pp.
- Kobayashi Y, Kobayashi K, Umehara K, Dohra H, Murata T, Usui T, Kawagishi H (2004) Purification, characterization, and sugar binding specificity of an N-glycolylneuraminic acid-specific lectin from the mushroom *Chlorophyllum molybdites*. The journal of Biological Chemistry 272 (51): 53048–53055. <https://doi.org/10.1074/jbc.M407997200>
- Kornerup A, Wancher JH (1978) Methuen Handbook of Colour. Eyre Methuen, London, 252 pp.
- Largent DL, Abell-Davis SE (2011) Observations on *Inocephalus virescens* comb. nov. and *Alboleptonia stylophora* from north-eastern Queensland. Mycotaxon 116: 231–245. <https://doi.org/10.5248/116.23>
- Largent DL, Johnson D, Watling R (1986) How to Identify Mushrooms to Genus III: Microscopic Features. Mad River Press, Eureka, California, 148 pp.
- Lehmann PF, Khazan U (1992) Mushroom poisoning by *Chlorophyllum molybdites* in the Midwest United States. Micopathologia 118: 3–13.
- Marian FER, Jiménez SN, Malpica FL, Rosero BB (2011) Skin test reactivity of allergic subjects to basidiomycetes' crude extracts in a tropical environment. Medical Mycology 49 (8): 887–891. <https://doi.org/10.3109/13693786.2011.574238>
- Meijer AAR, Amazonas MALA, Rubio GBG, Curial RM (2007) Incidences of poisonings due to *Chlorophyllum molybdites* in the state of Paraná, Brazil. Brazilian Archives of Biology and Technology 50 (3): 479–488.
- Pegler DN (1983) Agaric flora of the Lesser Antilles. Kew Bulletin Additional Series 9: 1–668.
- Pérez-Silva E, Herrera T (1986) Macromicetos tóxicos: *Chlorophyllum molybdites*, causante de micetismo gastrointestinal en México. Revista de la Sociedad Mexicana de Historia Natural 38: 27–33.
- Piepenbring M (2008) Reportes nuevos de agaricales para Panamá. Acta Biologica Panamensis 1: 22–38.
- Razaq A, Shahzad S (2012). New records of Agaricaceae from Pakistan. Pakistan Journal of Botany 44 (4): 1475–1477.
- Reid DA, Eicker A (1991) A comprehensive account of *Chlorophyllum molybdites*. Botânica Bulletin Academia Sinica 32: 317–334.
- Romano GM, Iannone L, Novas MV, Carmarán C, Romero AI, Lopez SE, Lechner BE (2013) Hongos tóxicos en la ciudad de Buenos Aires y alrededores. Medicina 73: 406–410.
- Sobestiansky G (2005) Contribution to a macromycete survey of the states of Rio Grande do Sul and Santa Catarina in Brazil. Brazilian Archives of Biology and Technology 48 (3): 437–457.
- Vellinga EC (2001) *Chlorophyllum* Mass. In: Noordeloos ME, Kuyper ThW, Vellinga EC (Eds) Flora Agaricina Neerlandica. August Aimé Balkema Publisher, Tokyo, 74–75.
- Vellinga EC (2002) New combinations in *Chlorophyllum*. Mycotaxon 83: 415–417.
- Vellinga EC (2003a) *Chlorophyllum* and *Macrolepiota* (Agaricaceae) in Australia. Australian Systematic Botany 16: 361–370.
- Vellinga EC (2003b) Type studies in Agaricaceae – *Chlorophyllum rachodes* and allies. Mycotaxon 85: 259–270.
- Vellinga EC (2004) Ecology and distribution of lepiotaceous fungi (Agaricaceae)—a review. Nova Hedwigia 78: 273–299. <https://doi.org/10.1127/0029-5035/2004/0078-0273>
- Vellinga EC (2006) *Chlorophyllum* in Great Britain. Field Mycology 7 (4): 136–140.
- Vellinga EC, Kok RPJ (2002) Proposal to conserve the name *Chlorophyllum* Masse against *Endoptychum* Czern. (Agaricaceae). Taxon 51: 563–564.
- Vellinga EC, Kok RPJ, Bruns TD (2003) Phylogeny and taxonomy of *Macrolepiota* (Agaricaceae). Mycologia 95 (3): 442–456.
- Yongabi K, Agho M, Martinez CD (2004) Ethnomycological studies on wild mushrooms in Cameroon, Central África. Micologia Aplicada International 16 (2): 34–36.
- Zoberi MH (1972) Tropical macrofungi, some common species. Hafner Publishing, New York, 158 pp.